

THERMAL DESIGN AND ON-ORBIT PERFORMANCE OF THE MULTI-ANGLE IMAGING SPECTRORADIOMETER INSTRUMENT

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Abstract

The Multi-angle Imaging SpectroRadiometer (MISR) is one instrument in a suite of five instruments flying onboard NASA's Earth Observing System (EOS) Terra Platform. MISR was launched on NASA's EOS flagship "Terra" on December 18, 1999. It is a pushbroom camera instrument developed by the Jet Propulsion Laboratory for NASA. The nominal mission lifetime for the instrument is 6 years. The Terra Platform was placed in a sun-synchronous near-circular polar orbit with an inclination of 98.3 degrees, mean altitude of 705 km and a 98.88 minute orbit period. MISR views the sunlit Earth simultaneously at nine widely spaced angles, collects global images with high spatial detail in four colors at every angle. MISR's four spectral bands are at 446.4, 557.5, 671.7 and 866.4 nanometers and the corresponding bandwidths are 41.9, 28.6, 21.9 and 39.7 nanometers. The images acquired once calibrated provide accurate measurements of brightness, contrast and color of reflected sunlight. Changes in the reflection at different view angles provides a means to distinguish between different types of atmospheric particles (aerosols), cloud forms and land surface covers. Using stereoscopic techniques, MISR data enables construction of 3-dimensional models and more accurate estimates of the total amount of sunlight reflected by Earth's diverse environments.

The thermal design provides three temperature zones required by the instrument, namely -5°C , 5°C and 20°C . The detectors are cooled by thermoelectric coolers to -5°C and a nadir radiator provides cooling for the optical bench and nine cameras at 5°C . The remaining electronics require ambient temperatures near 20°C .

The thermal control system (TCS) consists of passive and active elements to maintain the instrument within allowable flight temperature (AFT) limits. Passive thermal control includes multi-layer insulation blankets, thermal straps, and surface coatings to manage the transfer of waste energy from sources through structures and ultimately to the nadir radiators. Active thermal control employs close-loop heater control systems for the detector and optical bench. Operational and replacement heaters are used in the instrument operational science mode and survival heaters are used in the survival mode. The waste heat from all the components is conducted to the heat rejecting nadir radiator surfaces. While in survival mode, the instrument is not operating and the survival heaters maintain equipment temperatures within the allowable non-operating limits. In safe mode, the spacecraft attitude is such that the effective sink temperature for the radiator panels drops from -30°C to -40°C . To maintain equipment temperatures within non-operating cold limits, the system electronics remains powered, replacement heaters are used for remaining electronics and the optical bench heater remains powered.

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